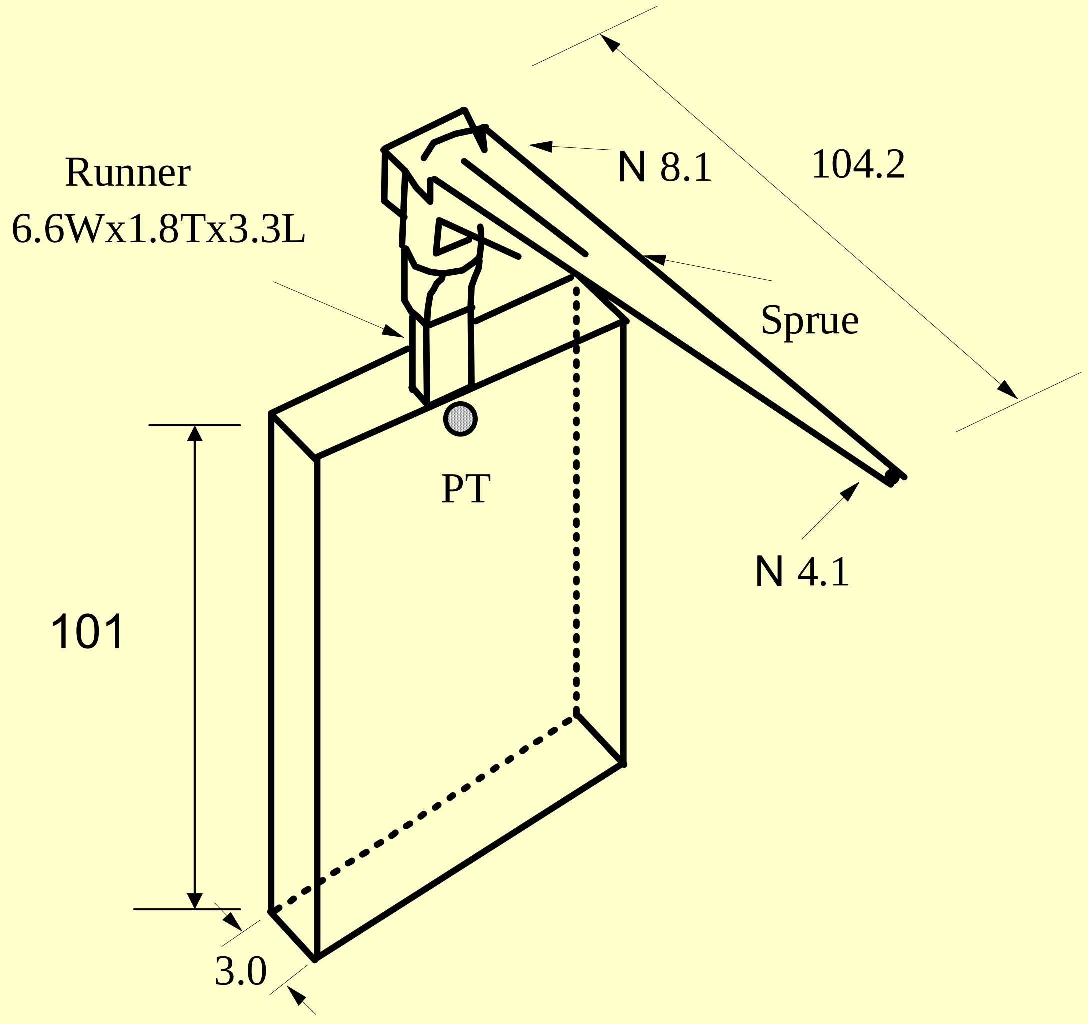
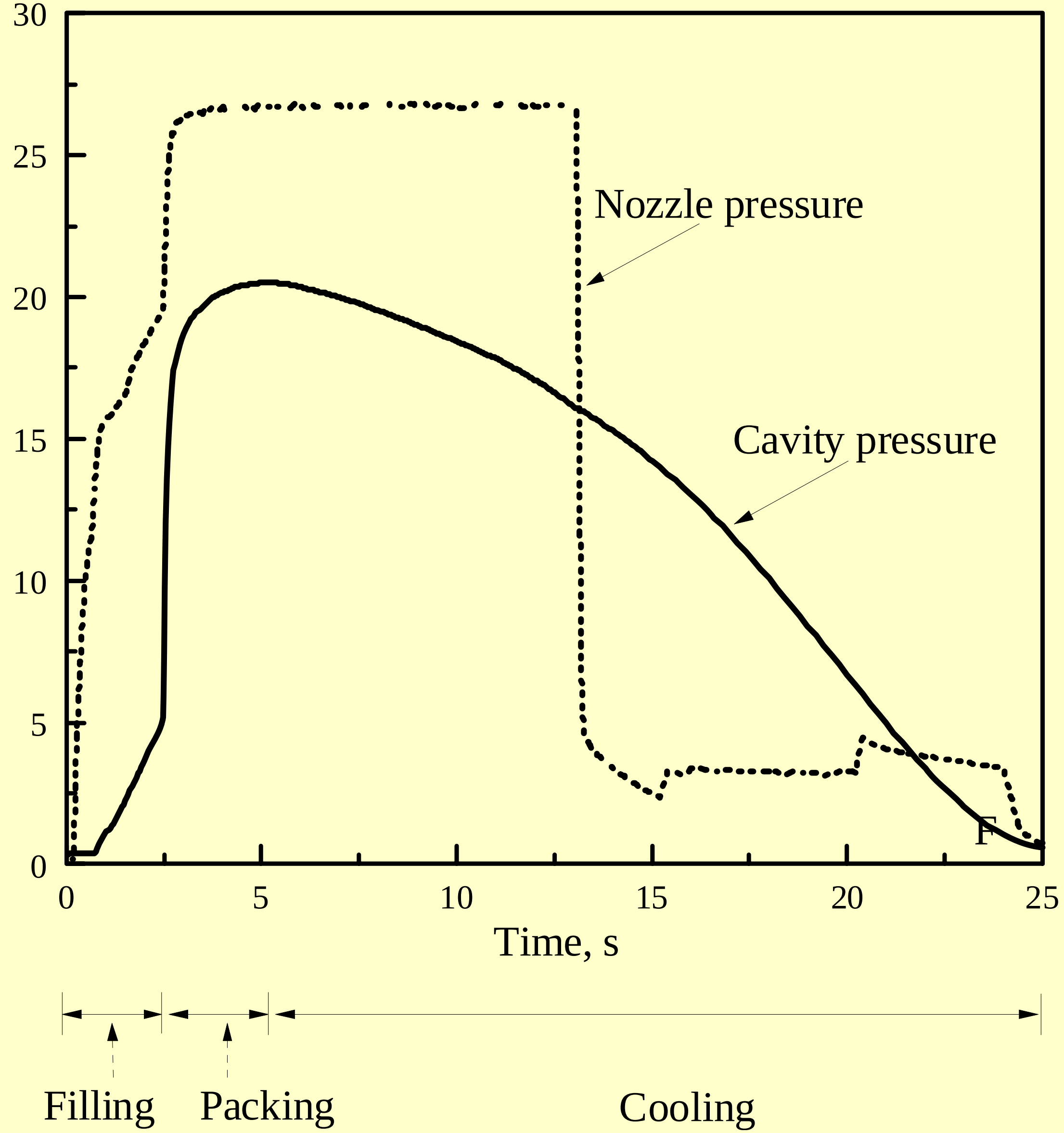
CAVITY DIMENSIONS



PRESSURE PROFILES



MODELS

$$\rho Cp\frac{\partial T}{\partial t}-\left[\frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right)+\frac{\partial}{\partial y}\left(k\frac{\partial T}{\partial y}\right)+\frac{\partial}{\partial z}\left(k\frac{\partial T}{\partial z}\right)\right]+\rho Cp\left(u_x\frac{\partial T}{\partial x}+u_y\frac{\partial T}{\partial y}\right)=\eta\gamma^2$$

$$\frac{\partial}{\partial x}\left(S\frac{\partial p}{\partial x}\right)+\frac{\partial}{\partial y}\left(S\frac{\partial p}{\partial y}\right)=0$$

$$S=\int_0^b\frac{z^2dz}{\eta}$$

BOUNDARY CONDITIONS

Dirichlet

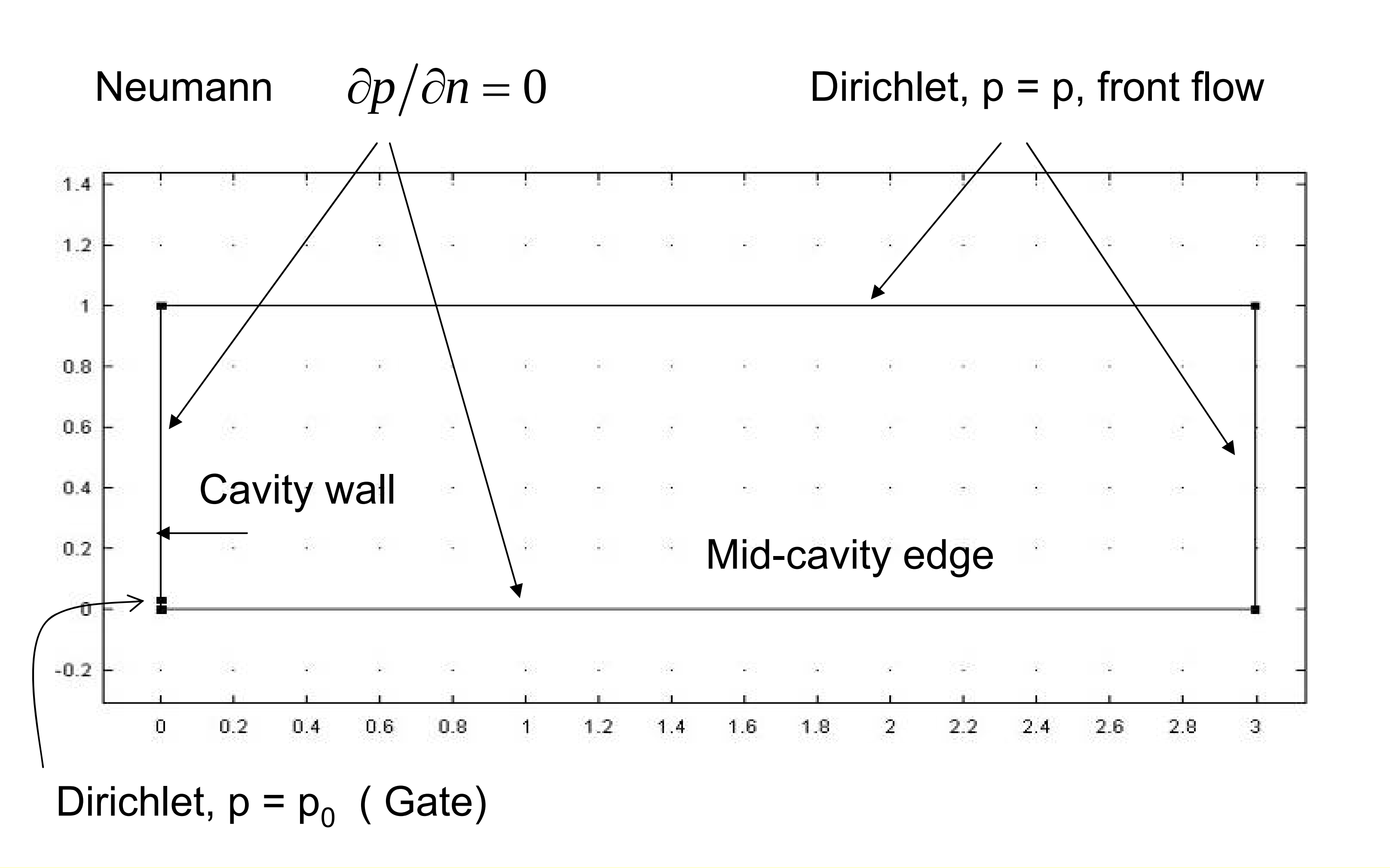
- Cavity entry ($x = 0$, $0 \le y \le g_w$, $0 \le z \le g_h$)
  - $T = Te$, $p = p_o$
- Cavity walls
  - $T = T_w$,
- Mid-cavity gapwise plane ($y = 0$)
  - Neumann
    $\partial p / \partial n = 0$
    $\partial T / \partial n = 0, \quad \partial p / \partial n = 0$

$$p_0 = \begin{cases} \alpha t, & t_{fill} \ge t \ge 0 \\ p_{ef} + \left(p_p - p_{ef}\right)\left(1 - \exp\left(-t/\tau\right)\right), & t_{pack} \ge t \ge t_{fill} \end{cases}$$

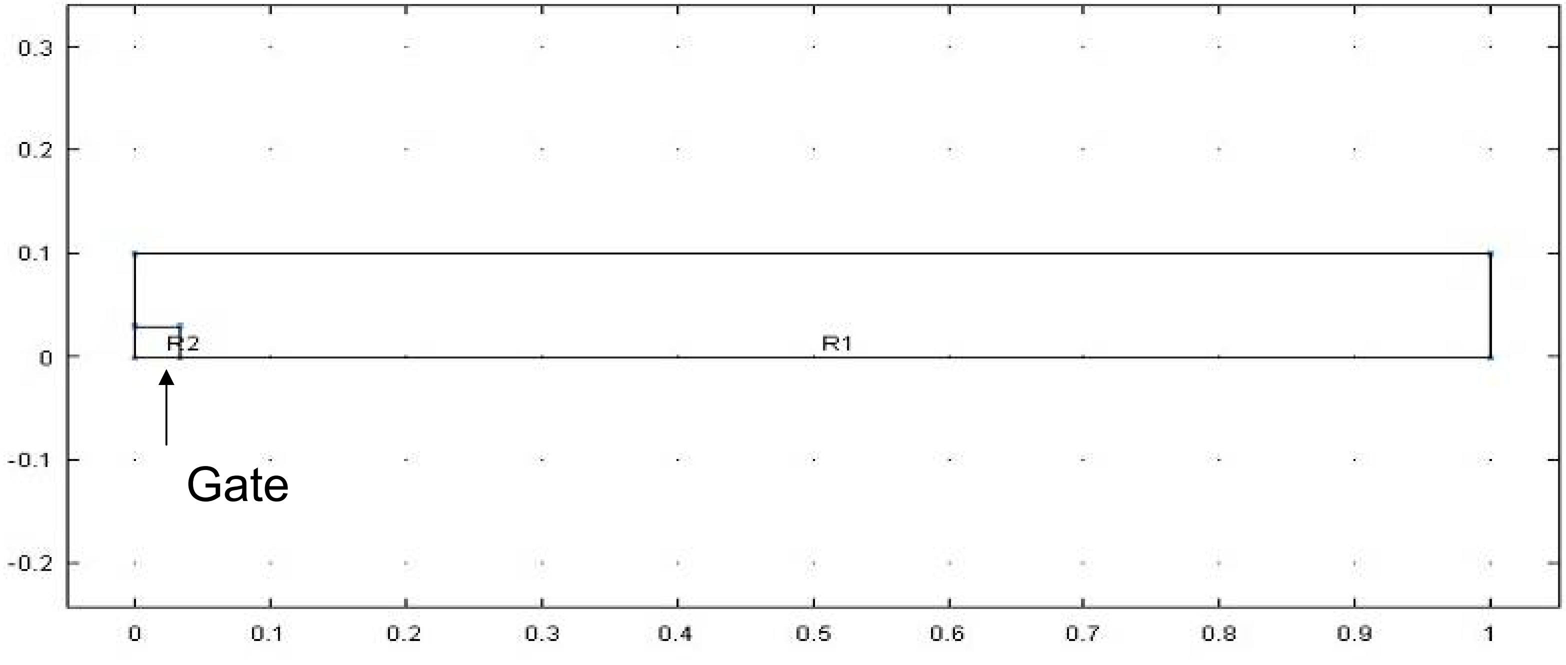
- t_{fill} = 1 s, t_{pack} = 2.5 s
- α = 5.19 MPa/s, p_{ef} = 5.19 MPa, p = 22.06 MPa, τ = 0.16 s.

INITIAL CONDITIONS $T = T_w$, p = 0

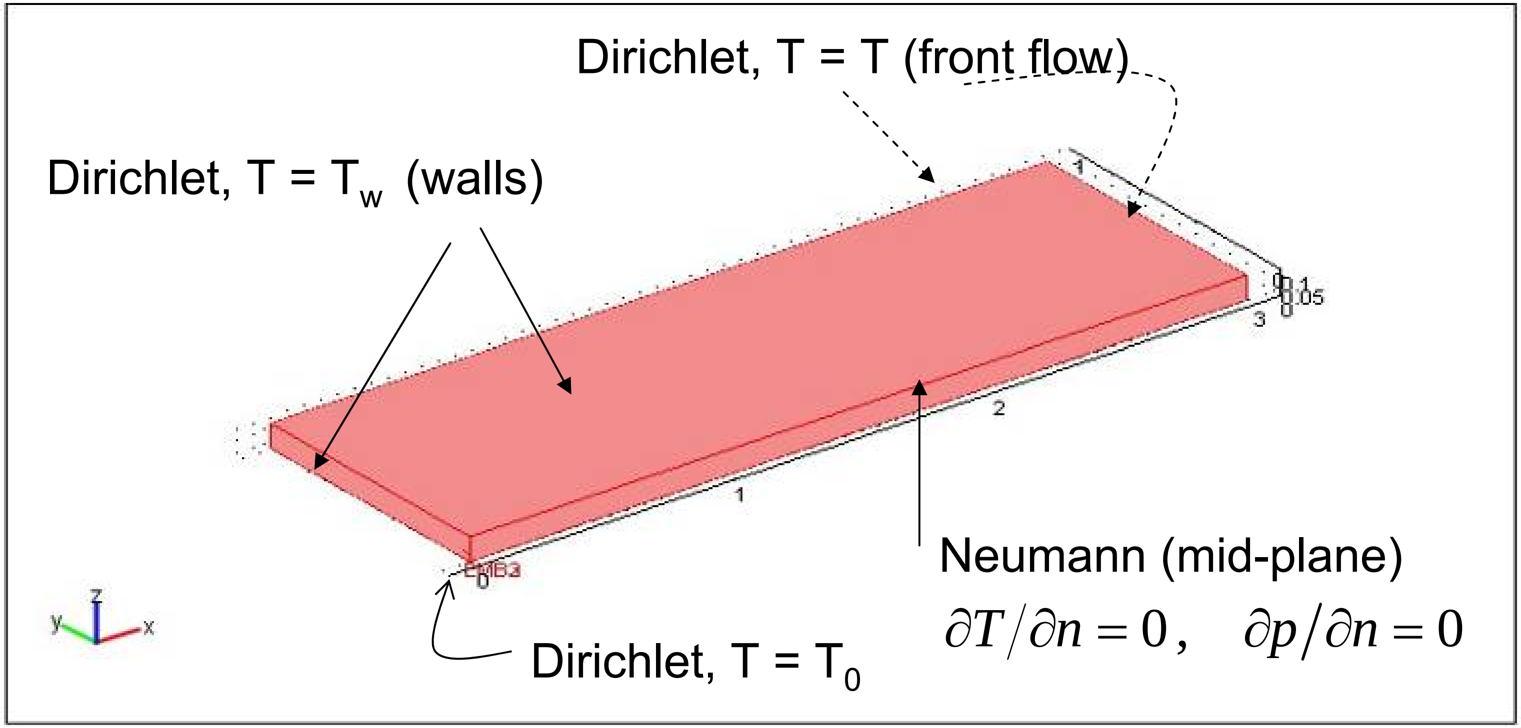
MIDCAVITY X-Y PLANE, GEOM 1



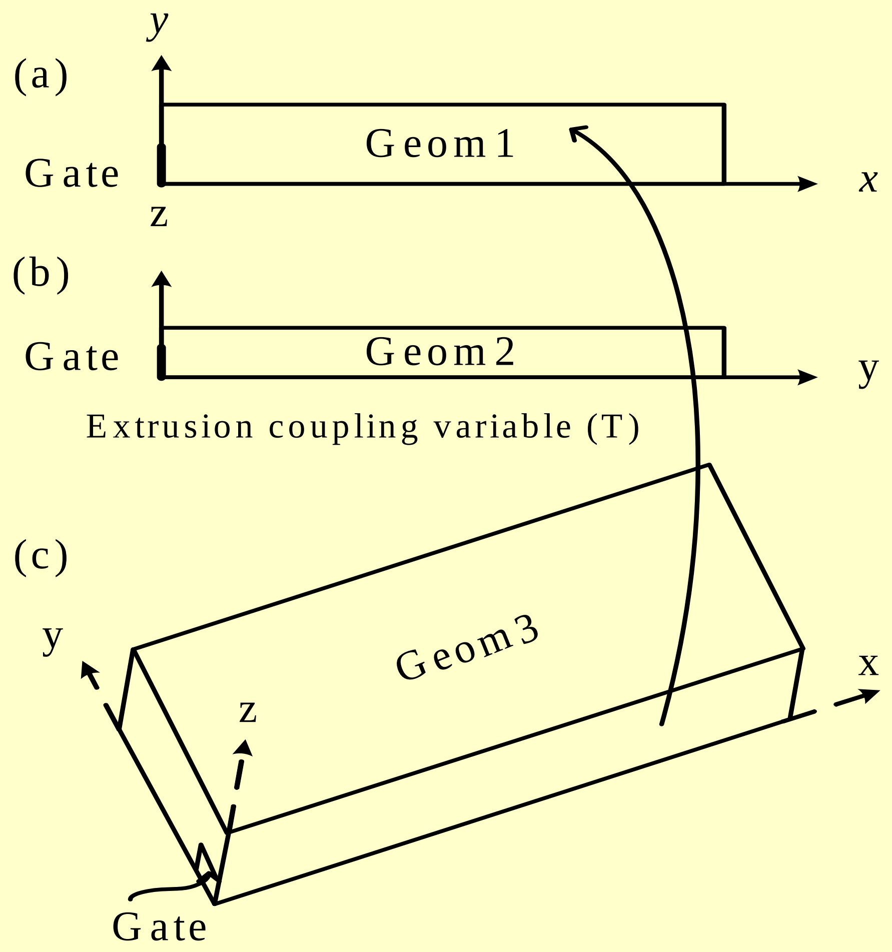
MIDCAVITY Y-Z PLANE, GEOM 3



MIDCAVITY, GEOM 3



GEOMETRY MODELING



PROPERTY MODELS

$$\eta = \eta_o \left[1 + \left(\frac{\eta_o}{\dot{\gamma}\,\tau^*} \right)^{1-n} \right]^{-1}$$

$$\eta_o = B \exp\left(\frac{T_b}{T} \right) \exp\left(\beta p \right)$$

$$\dot{\gamma} = \sqrt{\left(\partial u_x / \partial z \right) + \left(\partial u_y / \partial z \right)}$$

$$v = v_o \left[1 - C \log\left(1 + \frac{p}{B} \right) \right]$$

$$v_o = \begin{cases} b_{1,l} + b_{2,l} \overline{T} & \text{if} \quad T > T_t \\ b_{1,s} + b_{2,s} \overline{T} & \text{if} \quad T < T_t \end{cases},$$

$$B\left(T\right) = \begin{cases} b_{3,l} \exp\left(-b_{4,l} \overline{T} \right) & \text{if} \quad T > T_t \\ b_{3,s} \exp\left(-b_{4,s} \overline{T} \right) & \text{if} \quad T < T_t \end{cases}$$

$$C_p = c_1 + c_2 \tilde{T} + c_3 \tanh\left(c_4 \tilde{T} \right),$$

$$k = \lambda_1 + \lambda_2 \hat{T} + \lambda_3 \tanh\left(\lambda_4 \hat{T} \right)$$

$$S = \int_0^b \frac{z^2 dz}{\eta}$$

$$\tilde{T} = T - c_5, \quad \hat{T} = T - \lambda_5$$

$$\overline{T} = T - b_5, \quad T_t\left(p \right) = b_5 + b_6 p$$

PDE COEFFICIENT FORM

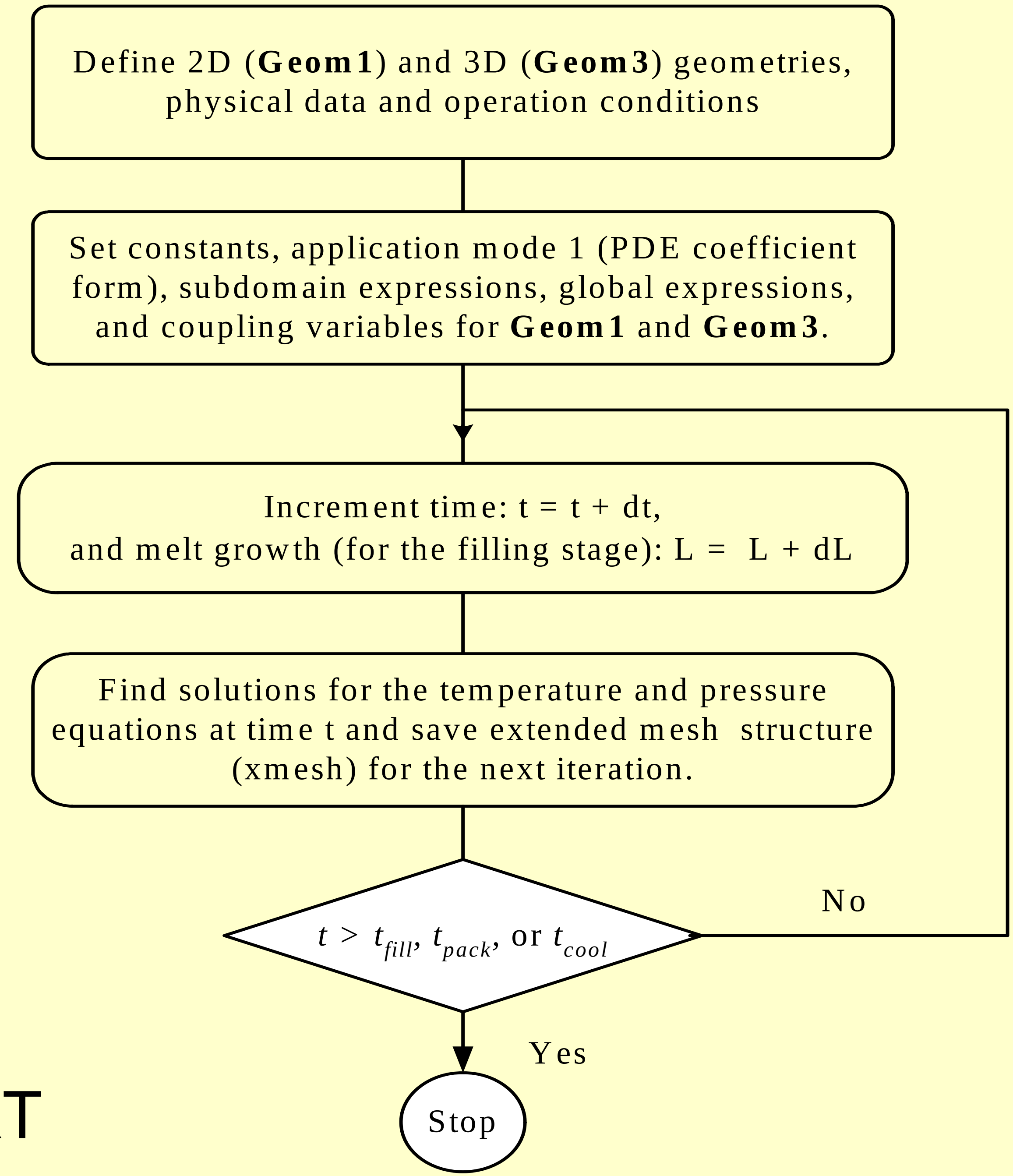
$$d_a \frac{\partial u}{\partial t} - \nabla \cdot \left(c\nabla u + \alpha u - \gamma \right) + \beta \cdot \nabla u + au = f$$

$$u = \begin{bmatrix} p \\ T \end{bmatrix},\ d_a = \begin{bmatrix} 0 \\ \rho C_p \end{bmatrix},\ c = \begin{bmatrix} \hat{S} \\ \hat{k} \end{bmatrix}$$

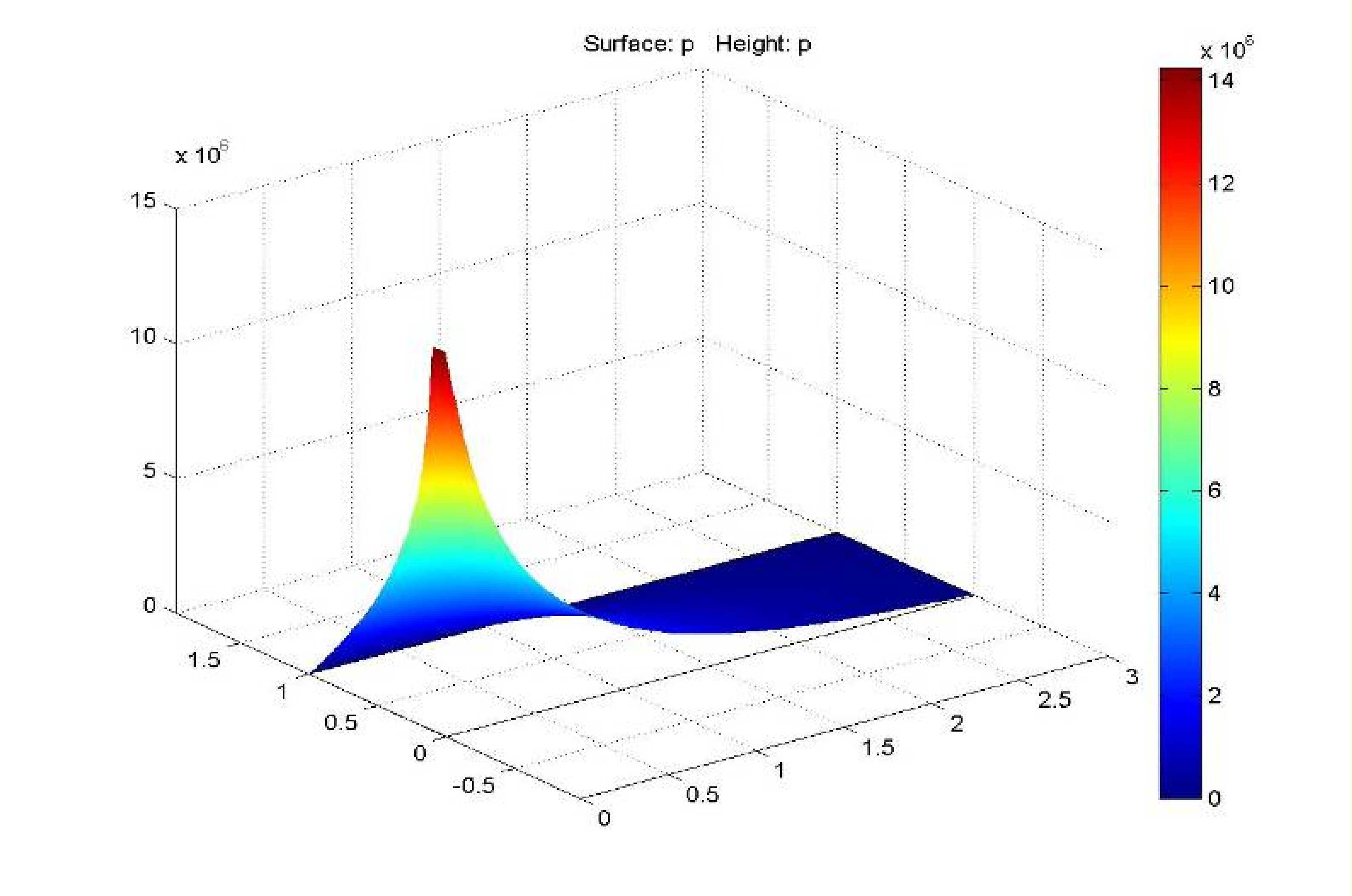
$$\beta = \begin{bmatrix} 0 & 0 & \\ \rho C_p u_x \big/ scalex^2 & \rho C_p u_y \big/ scaley^2 & 0 \end{bmatrix},\ f = \begin{bmatrix} 0 \\ \cdot \\ \eta \gamma^2 \end{bmatrix}$$

$$hu = r,\ n \cdot \left(c\nabla u + \alpha u - \gamma \right) + qu = g - h^T \mu$$

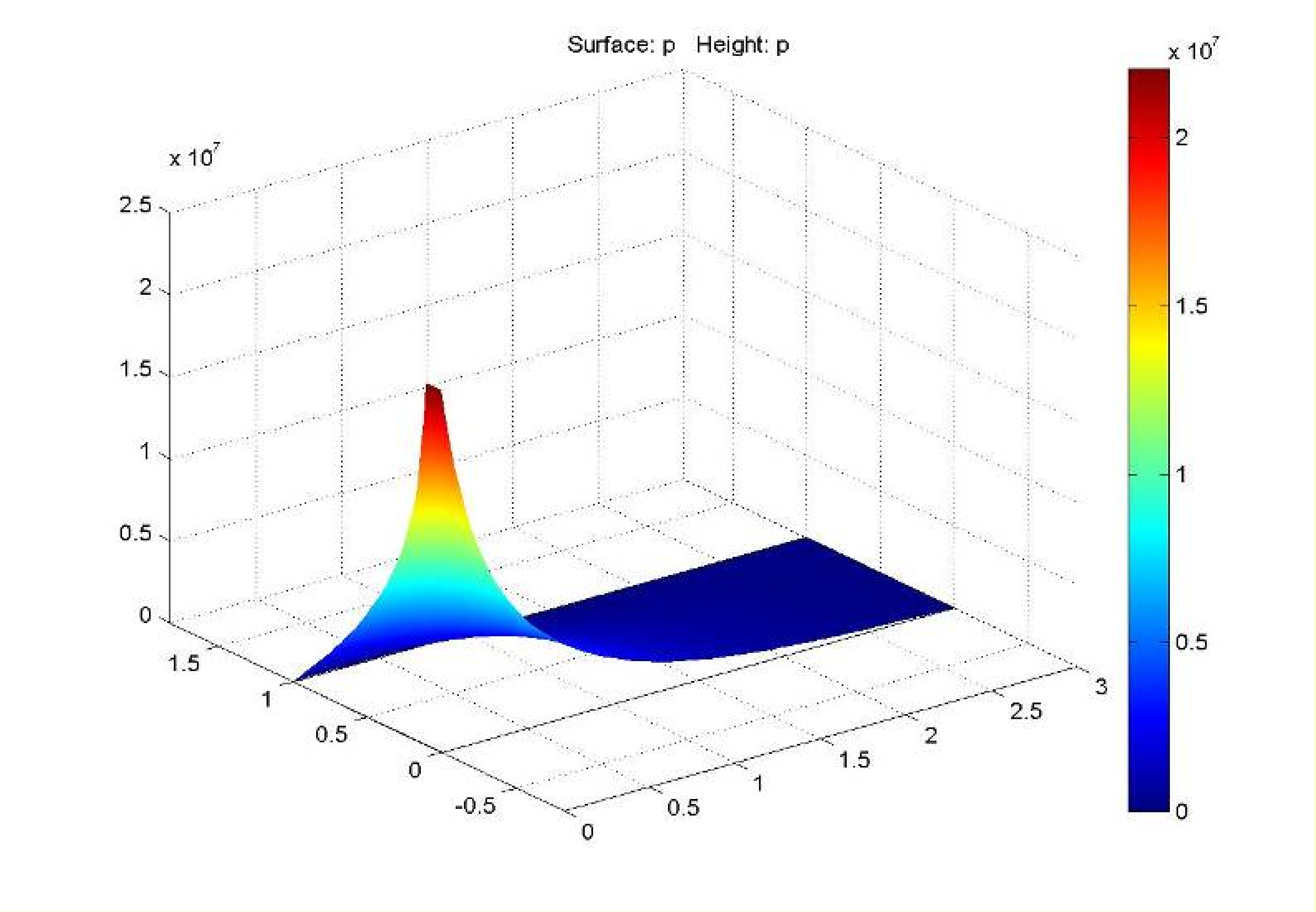
PROGRAM FLOWCHART



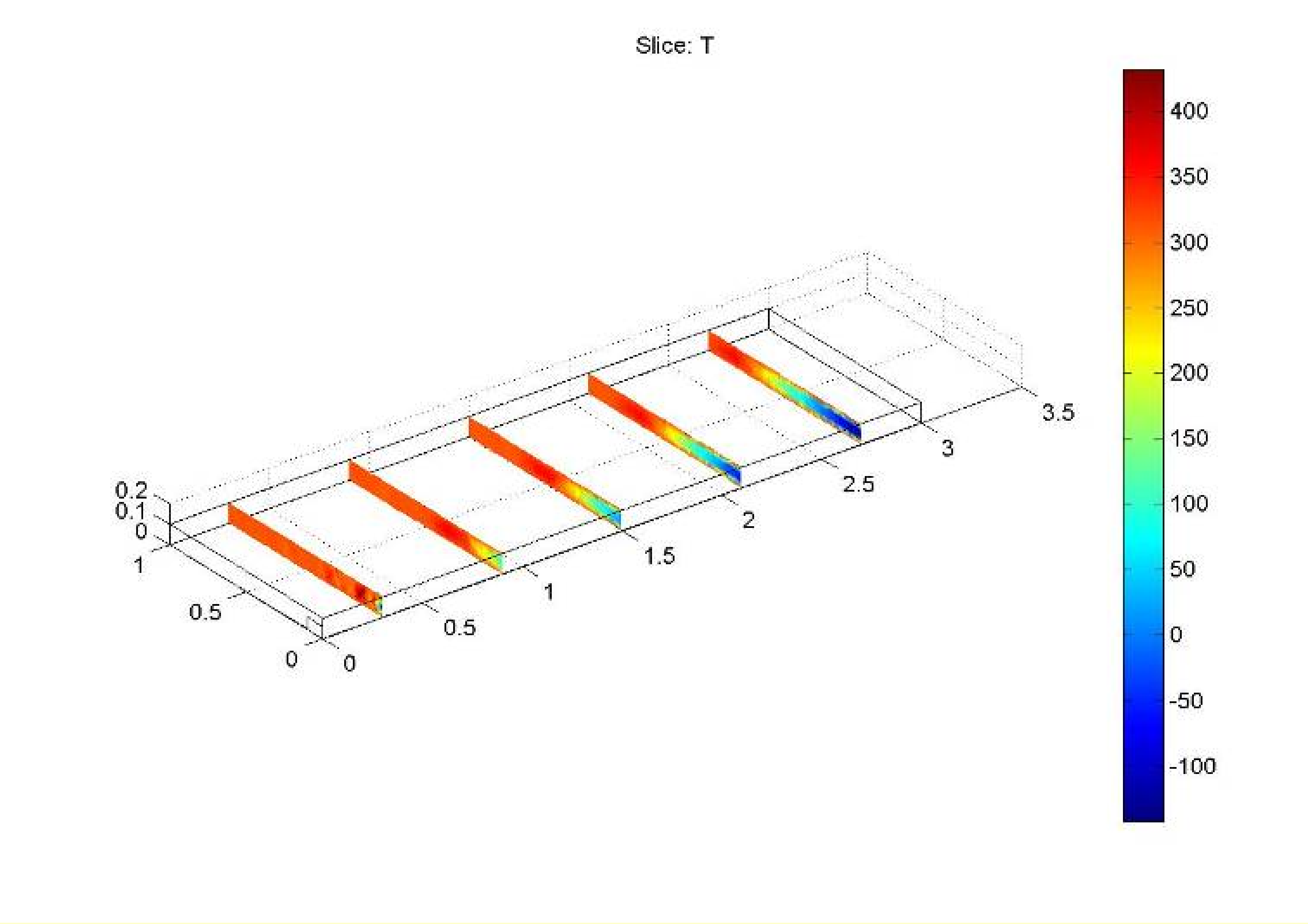
FILLING PRESSURE DISTRIBUTION



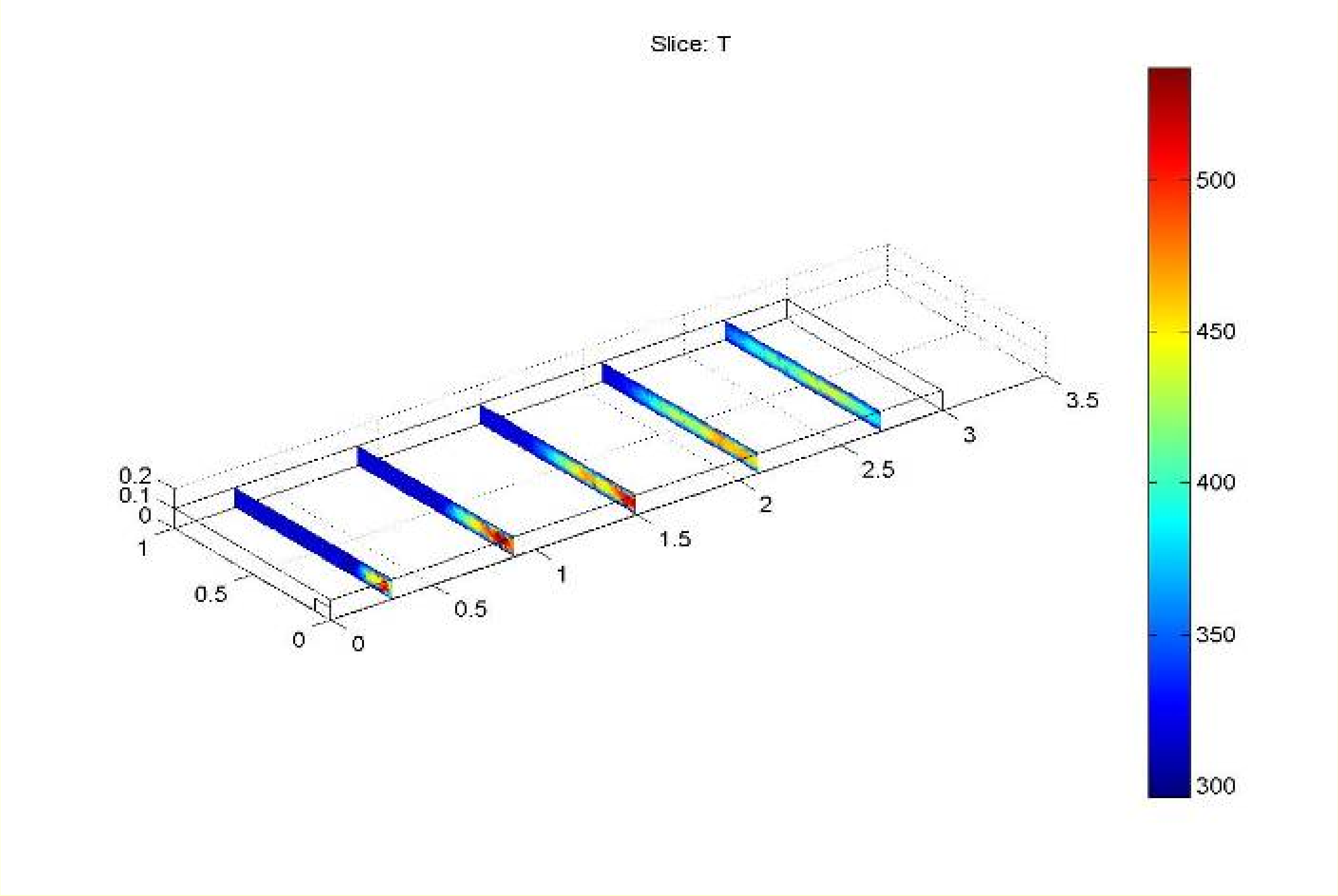
PACKING PRESSURE



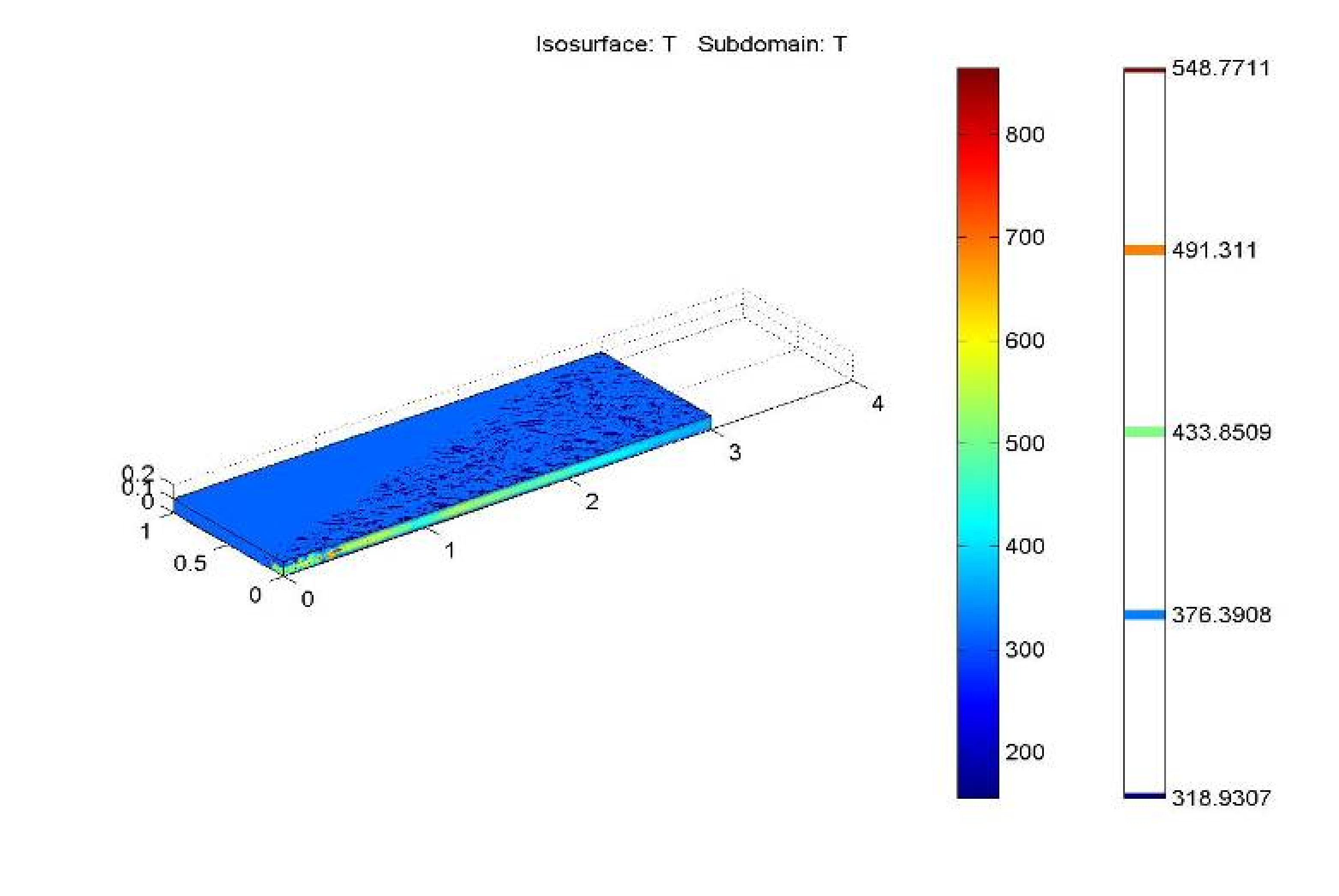
END OF FILLING TEMPERATURES



END OF PACKING TEMP DIST.



END OF PACKING TEMPERATURES



CONCLUSIONS

- This preliminary work has presented an application for determining pressure and temperature distributions in a rectangular cavity.

- Future work:
- Use of extrusion coupling variables for pressure and temperature between 2D and 3D geometries, and the streamline upwind technique to stabilize the results.
- Improvement in the models by using a time varying model and a 3D geometry for the cavity pressure.
- Inclusion in the results of process variables such as the melt flow front and interface positions during the filling stage.
- Model validation.

- QUESTIONS